

Chapter 7 Homework Solutions

1. $B_{DSB} = 2B_{baseband} = 2f_m$

a) $B_{baseband} = 10 \text{ kHz}$, $B_{DSB} = 2(10 \text{ kHz}) = 20 \text{ kHz}$

b) 200 kHz

c) 2 MHz

d) 20 MHz

2. $f_c = 10^6$, $USB = f_c + f_m$, $LSB = f_c - f_m$

a) $USB = 10^6 + 10^4 = 1.01 \text{ MHz}$ $LSB = 10^6 - 10^4 = 0.99 \text{ MHz}$

b) $USB = 10^6 + 10^5 = 1.1 \text{ MHz}$ $LSB = 10^6 - 10^5 = 0.9 \text{ MHz}$

c) $USB = 2 \text{ MHz}$, $LSB = 0$

d) $USB = 10^7 + 10^6 = 11 \text{ MHz}$ $LSB = 10^7 - 10^6 = 9 \text{ MHz}$

3. $m(t) = E_m \cos(\omega_m t)$ $E_c \cos(\omega_c t)$, $R = 100$, $P = E_m^2 E_c^2 / 4R = E_m^2 E_c^2 / 400$

a) $E_c^2 / 400$ b) $10^{-6} E_c^2 / 400$ c) $10^4 E_c^2 / 400$ d) $10^{-12} E_c^2 / 400$

4. $f_c = 10^6 / 2\pi$, $R = 75$, $a(t) = 50 \cos(20t)$

a) 50 b) 10^6 c) 20 d) $f_m = 20 / 2\pi$, $B = 2f_m = 20 / \pi$ e) $USB = B/2 = 20 / 2\pi$, $\omega = \omega_c + \omega_m = 10^6 + 20$

f) $LSB = B/2 = 20 / 2\pi$, $\omega = \omega_c - \omega_m = 10^6 - 20$ g) $P = E_m^2 E_c^2 / 4R = 50^2 E_c^2 / 300 = 8.33 E_c^2$

5. $M = E_m / E_c$, % = 100m

a) $m = 10 / 10 = 1$, 100% b) $m = 10 / 20 = 0.5$, 50% c) $m = 20 / 10$, overmodulated d) $m = 1$, 100%

6. $P = E_c^2 / 2R (1 + m^2 / 2)$, $m = 1$, $R = 50$, $P = E_c^2 / 100 (3/2) = 3 E_c^2 / 200$

a) $P = 3 / 200 (100) = 1.5$ b) $3 / 200 (10^4) = 150$ c) $3 / 200 (10^{-6}) = 1.5 \times 10^{-8}$ d) $3 / 200 (10^{-12}) = 1.5 \times 10^{-14}$

7. $\omega_c = 10^5$, $E_c = 20$, $R = 100$, $E_m = 5$, $\omega_m = 2e4$, DSB-LC

a) $m(t) = (a(t) + E_c) \cos \omega_c t = (5 \cos 2e4t + 20) \cos 1e5 t$

b) $E_c = 20$ c) $\omega_c = 1e5$ d) $E_m = 5$ e) $\omega_m = 2e4$ f) $LSB = f_m @ \omega_c - \omega_m = 8e4$

g) $USB = f_m @ \omega_c + \omega_m = 12e4$ h) $2f_m = 2(2e4) / 2\pi = 6.36e3$ i) $m = E_m / E_c = 0.25$

j) $P = E_c^2 / 2R (1 + m^2 / 2) = 20^2 / 2(100) (1 + 0.25^2 / 2) = 2.06$

8. $\alpha = m^2 / (2 + m^2) = 0.03$

9. All power in sidebands

10. Greatest efficiency when $m = 1$, therefore $\alpha_{\max} = 1/(2 + 1) = 0.33$

11. Cheap receivers

12. $E_m/E_c = m = 1$, $E_m = E_c$, $V_{\max} = E_m + E_c = 10$, $E_m = E_c = 5$

if $m = 0$, $E_c = 5 = V_{\max}$

13. SSB: $m(t) = E_c E_m / 2 \cos(\omega_c + \omega_m)t$ USB, $m(t) = E_c E_m / 2 \cos(\omega_c - \omega_m)t$ LSB

$$P_{SSB} = (E_c E_m / 2)^2 / 2R = E_c^2 E_m^2 / 8R = E_c^2 (100 / 8(50)) = E_c^2 / 4$$

14. Disregard